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# PRESCRIBING PATTERNS AND DRUG-RELATED PROBLEMS IN ISCHEMIC HEART DISEASE: A PROSPECTIVE OBSERVATIONAL STUDY AT A TERTIARY CARE TEACHING HOSPITAL

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## ABSTRACT

Ischemic heart disease remains the largest single contributor to cardiovascular mortality worldwide, and those affected seldom carry a single diagnosis. This prospective observational study was undertaken in the cardiology inpatient unit of a tertiary care teaching hospital over six months to describe prescribing practice, profile coexisting illness, and identify drug-related problems in this population. Ninety consecutive adults admitted with ischemic heart disease or a related cardiovascular condition were enrolled after written informed consent. Demographic details, diagnoses, coexisting conditions and complete medication data were recorded on a structured form and reviewed daily until discharge. Drug-related problems were detected through independent medication review and classified using the Pharmaceutical Care Network Europe classification, version 9.1. Data were analysed descriptively and the chi -square test was applied, with a probability value below 0.05 regarded as significant. The cohort was predominantly male and elderly, most patients falling within the seventh decade of life, and the male excess was statistically significant. Diabetes mellitus and hypertension were the dominant coexisting conditions. Prescribing averaged between six and seven medicines per patient. Antiplatelet agents were used most often, led by aspirin and ticagrelor, followed by diuretics and lipid-lowering agents, among which atorvastatin was

overwhelmingly preferred. Twenty drug-related problems were recorded; adverse drug reactions predominated, followed by medication errors and drug–drug interactions, and seven of every ten problems fell within the treatment-safety domain. Prescribing broadly reflected guideline-directed therapy, yet a measurable and largely preventable burden of medication-related harm persisted, supporting routine clinical pharmacist review within cardiology inpatient care.

**KEYWORDS:** Ischemic heart disease, Drug utilization, Drug-related problems, Medication safety, Prescribing pattern, Clinical pharmacist.

## INTRODUCTION

Ischemic heart disease is the clinical expression of a sustained mismatch between myocardial oxygen supply and demand, and it continues to account for the largest single share of cardiovascular deaths recorded anywhere in the world.[1] In the great majority of patients the mechanism is atherosclerotic narrowing of the epicardial coronary arteries, although coronary vasospasm, microvascular dysfunction and congenital anomalies can reproduce an identical ischemic picture at angiography and at the bedside.[2] Successive Global Burden of Disease analyses have placed the condition among the foremost causes of death and disability in high-income and low-income regions alike, and the ranking has proved remarkably stable across three decades of surveillance.[3]

The burden is not distributed evenly. South Asian populations develop coronary disease roughly a decade earlier than Western cohorts and carry a heavier load of modifiable risk factors at the point of first presentation.[4] Because ischemic heart disease so rarely travels alone — diabetes mellitus, hypertension and dyslipidemia are its habitual companions — affected patients are almost invariably managed with several concurrent drug classes: antiplatelet agents, anticoagulants, beta-blockers, inhibitors of the renin–angiotensin system, statins, diuretics and antianginal drugs.[5] Drug utilization surveys from comparable settings have repeatedly documented this multi-class prescribing signature.[6]

Regimens of this complexity are evidence-based and demonstrably prolong life, but every additional agent widens the therapeutic front on which something can go wrong. Drug-related problems — events or circumstances involving medicines that actually or potentially interfere with a desired health outcome — arise from precisely this tension.[7] They encompass adverse drug reactions, dosing and administration errors, untreated indications, therapeutic

duplication and clinically significant drug–drug interactions, and they contribute materially to avoidable morbidity, prolonged length of stay and healthcare expenditure.[8] Medication errors alone account for a substantial and largely preventable fraction of this harm in general medical wards.[9] Hospitalised cardiac patients, by virtue of polypharmacy, advanced age and narrow therapeutic margins, sit at the sharp end of that risk.[10]

Drug utilization research, as conceived by the World Health Organization, examines the marketing, distribution, prescription and use of medicines within a society, with particular attention to the medical, social and economic consequences of that use.[11] Prescribing-pattern studies in cardiovascular disease have been reported from a number of centres in this country and abroad.[12] Several have described the drugs used without examining what went wrong with them,[13] while others have quantified problems without characterising the prescribing that produced them.[14] Relatively few have combined a detailed drug utilization analysis with a structured, framework-based assessment of drug-related problems within a single inpatient cohort with ischemic heart disease.[15] Documenting both dimensions in the same patients matters, because it is only when the pattern of prescribing and the pattern of harm are laid side by side that one can see where pharmaceutical care will repay the effort invested in it.

The present study was therefore undertaken to describe the drug utilization pattern among inpatients admitted with ischemic heart disease and related cardiovascular conditions at a tertiary care teaching hospital, to characterise their comorbidity profile, and to identify and classify the drug-related problems encountered during hospitalisation, with a view to defining the points at which pharmacist-led intervention would be most useful.

## MATERIALS AND METHODS

### Study design and setting

This was a prospective, observational study carried out over six months in the cardiology inpatient unit of a tertiary care teaching hospital attached to S. Nijalingappa Medical College, Hospital and Research Centre, Bagalkote, Karnataka, India. The unit receives both direct admissions and referrals from surrounding districts, and manages the full spectrum of acute and chronic coronary presentations.

### Study population and eligibility criteria

Adults aged 18 years and above, admitted with a diagnosis of ischemic heart disease or a related cardiovascular condition, who gave written informed consent were eligible for

inclusion. Patients managed solely on an outpatient basis and those unwilling to participate were excluded. Patients with coexisting conditions were deliberately retained rather than excluded, since the object of the study was to describe prescribing as it actually occurs rather than in an artificially uncomplicated sample.

**Sample size estimation**

The sample size was calculated on the expected proportion of patients receiving the most frequently used single agent. Taking that proportion as 50 per cent for aspirin, derived from a European treatment-pattern study in acute coronary syndrome,[16] and setting the confidence level at 95 per cent with an absolute precision of 10 per cent, the minimum requirement was approximately 90 patients. Ninety consecutive eligible inpatients were therefore enrolled.

**Data collection**

A structured data-collection form was used to record sociodemographic details, presenting diagnosis, coexisting conditions and complete medication data, including drug name, dose, route and frequency of administration. Information was drawn from case notes, treatment charts, investigation reports and interviews with the patient or an accompanying attendant. Every enrolled patient was reviewed daily for the duration of admission, and any alteration in medication orders or in relevant laboratory parameters was captured on the same form. Generic names have been used throughout; where a proprietary preparation was recorded in the chart, it was converted to its generic equivalent before analysis.

**Identification and classification of drug-related problems**

All collected records were reviewed independently by the investigating pharmacists in conjunction with an academic clinical pharmacist. Each drug-related problem identified was classified using the Pharmaceutical Care Network Europe classification, version 9.1, and assigned to one of its primary domains: treatment effectiveness, treatment safety, or treatment and administration process. To keep the findings clinically interpretable at ward level, every problem was additionally categorised in operational terms as an adverse drug reaction, a medication error or a drug–drug interaction. Drug information, dose ranges and interaction significance were verified against standard tertiary references and a recognised drug interaction database. Where the two reviewers differed, the classification was settled by discussion before entry.

### Statistical analysis

Data were entered into a spreadsheet and analysed using descriptive statistics, with categorical variables expressed as frequencies and percentages. The chi-square goodness-of-fit test was applied to the gender distribution and to the prevalence of diabetes mellitus, each tested against an expectation of equal distribution. A probability value below 0.05 was taken as statistically significant.

### Ethical considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of Hanagal Shri Kumareshwar College of Pharmacy, Bagalkote (reference number HSKCOP/IEC/25/6, dated 13 February 2025). Written informed consent was obtained from every participant before enrolment. Patient identifiers were removed at the point of data entry and confidentiality was maintained throughout the study and in this report. The investigation was conducted in accordance with the ethical principles of the Declaration of Helsinki.

## RESULTS

### Demographic and clinical profile

Ninety patients completed the study. The cohort was predominantly male, with 57 men (63.3 per cent) and 33 women (36.7 per cent); tested against an expectation of equal distribution, this male preponderance was statistically significant (chi-square = 6.40, p = 0.011). The largest age band was 60 to 69 years, accounting for 38.9 per cent of the cohort, followed by 70 to 79 years (22.2 per cent) and 50 to 59 years (20.0 per cent). Taken together, three-quarters of the patients were aged 50 years or above, confirming a distinctly elderly population. The age and gender distribution is set out in Table 1 and illustrated in Fig. 3.

Diabetes mellitus was the commonest coexisting condition, recorded in 38 patients (42.2 per cent), followed by hypertension in 34 (37.8 per cent). Renal, respiratory and cerebrovascular conditions were comparatively infrequent, together accounting for fewer than one in nine patients (Fig. 2). The difference in diabetes prevalence relative to an equal-distribution expectation did not reach statistical significance (chi-square = 2.18, p = 0.14). It is worth noting that the two dominant comorbidities are themselves indications for pharmacotherapy, and their presence largely explains the prescribing volume described below.

**Table 1: Demographic and comorbidity profile of the study population (N = 90).**

| Characteristic | Category | n | % |
|---|---|---|---|
| Gender | Male | 57 | 63.3 |
| | Female | 33 | 36.7 |
| Age group (years) | 30–39 | 2 | 2.2 |
| | 40–49 | 9 | 10.0 |
| | 50–59 | 18 | 20.0 |
| | 60–69 | 35 | 38.9 |
| | 70–79 | 20 | 22.2 |
| | 80–100 | 6 | 6.7 |
| Comorbidity* | Diabetes mellitus | 38 | 42.2 |
| | Hypertension | 34 | 37.8 |
| | Renal disease (CKD/DKD/AKI) | 5 | 5.6 |
| | Respiratory disease (COPD/asthma) | 3 | 3.3 |
| | Cerebrovascular accident | 2 | 2.2 |

**Patients could carry more than one comorbidity; percentages are calculated against the total cohort. CKD, chronic kidney disease; DKD, diabetic kidney disease; AKI, acute kidney injury; COPD, chronic obstructive pulmonary disease.*

**Drug utilization pattern**

A total of 585 drug entries were recorded across the 90 prescriptions analysed, giving a mean of 6.5 medicines per patient during admission — a figure that places the entire cohort within the conventional definition of polypharmacy. The class-wise distribution of these entries is presented in Table 2, and the agent-wise distribution within each class in Fig. 1.

**Table 2: Class-wise distribution of prescribed drug entries (N = 585).**

| Drug class | Prescription entries (n) | % of all entries (N = 585) | Leading agent within class (%) |
|---|---|---|---|
| Antiplatelets | 181 | 30.9 | Aspirin (48.6) |
| Diuretics | 102 | 17.4 | Furosemide (39.2) |
| Antilipidemics | 85 | 14.5 | Atorvastatin (90.6) |
| Antidiabetics | 60 | 10.3 | Insulin (40.0) |
| Anticoagulants | 49 | 8.4 | Enoxaparin (73.5) |
| Antibiotics | 49 | 8.4 | Ceftriaxone (40.8) |
| Antihypertensives | 33 | 5.6 | Metoprolol (42.4) |
| Antianginals | 26 | 4.4 | Nicorandil (38.5) |
| **Total** | **585** | **100.0** | — |

*Entries denote individual drug orders recorded across all 90 prescriptions rather than the number of patients exposed; a patient receiving two agents from the same class contributes two entries. Percentages are calculated against the total of 585 entries and are rounded to*

*one decimal place. The agent-wise percentage in the final column is calculated within its own class, not against the total.*

Antiplatelet agents dominated the prescribing profile, contributing almost a third of all drug entries. Aspirin led the class at 48.6 per cent, with ticagrelor at 34.8 per cent and clopidogrel at 14.4 per cent, a distribution consistent with widespread use of dual antiplatelet therapy in this setting. Among anticoagulants, the low-molecular-weight heparin enoxaparin predominated at 73.5 per cent, unfractionated heparin accounting for a further 22.4 per cent. Lipid-lowering prescribing was strikingly concentrated: atorvastatin accounted for 90.6 per cent of the class, leaving rosuvastatin a residual 9.4 per cent. Within the diuretic group, loop diuretics led, furosemide (39.2 per cent) marginally ahead of spironolactone (30.4 per cent) and torsemide (28.4 per cent). Metoprolol was the most frequently prescribed antihypertensive agent at 42.4 per cent, followed by sacubitril–valsartan at 24.2 per cent and telmisartan at 12.1 per cent. Nicorandil (38.5 per cent) and ivabradine (23.1 per cent) headed the antianginal group. Insulin (40.0 per cent) and metformin (21.7 per cent) accounted for the largest share of antidiabetic prescribing, with dapagliflozin contributing a further 15.0 per cent. Ceftriaxone was the single most commonly used antibiotic at 40.8 per cent, no other agent exceeding 6.1 per cent.

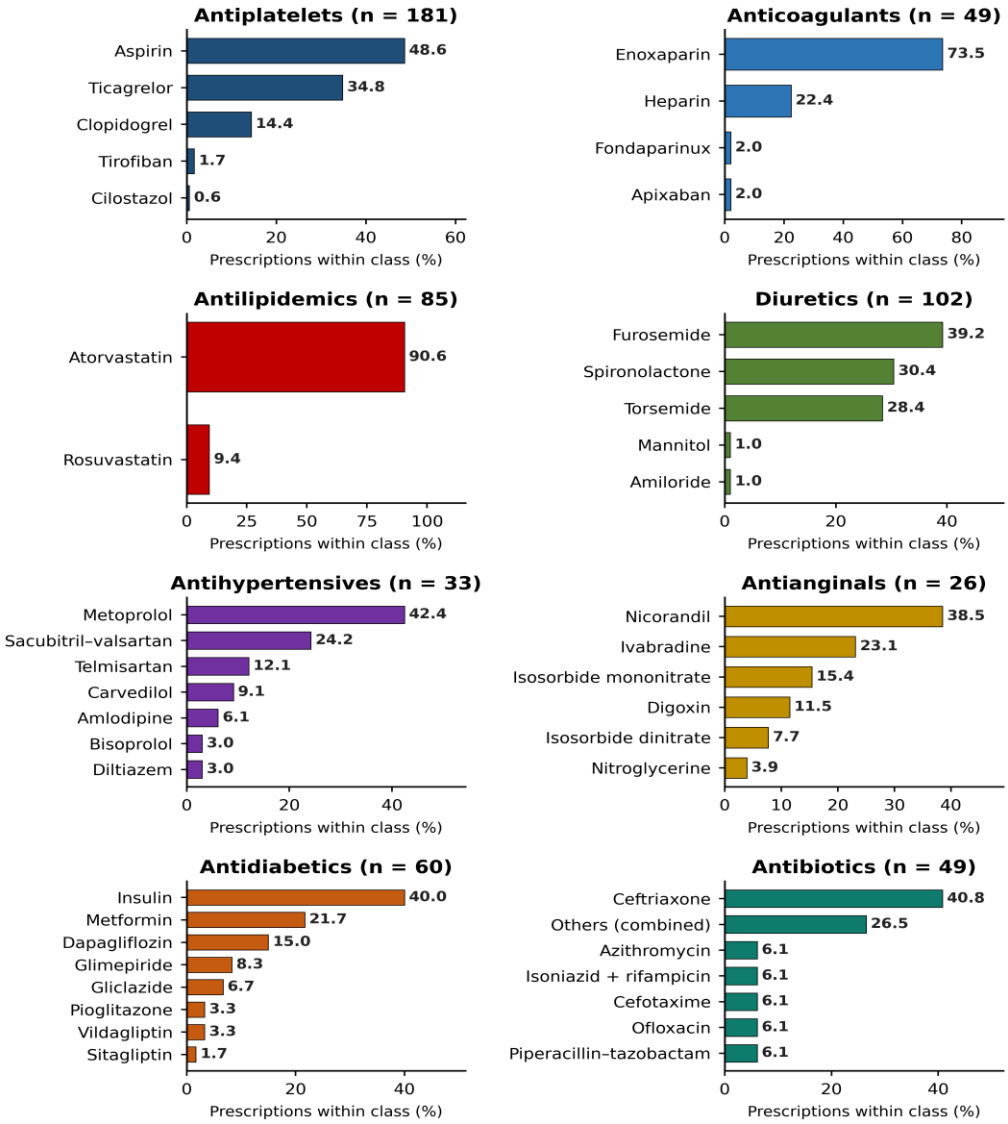


**Fig. 1: Agent-wise drug utilization within eight pharmacological classes, expressed as a percentage of entries within each class.**

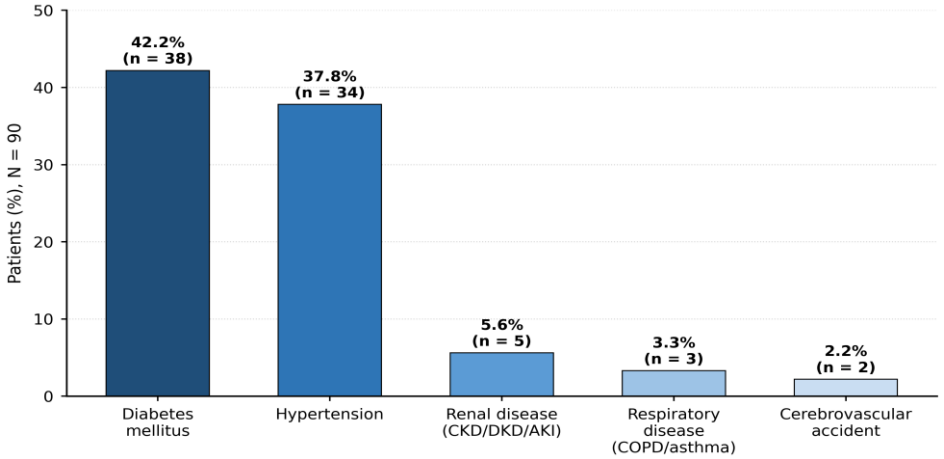


**Fig. 2: Comorbidity profile of the study population, expressed as a percentage of the total cohort (N = 90).**

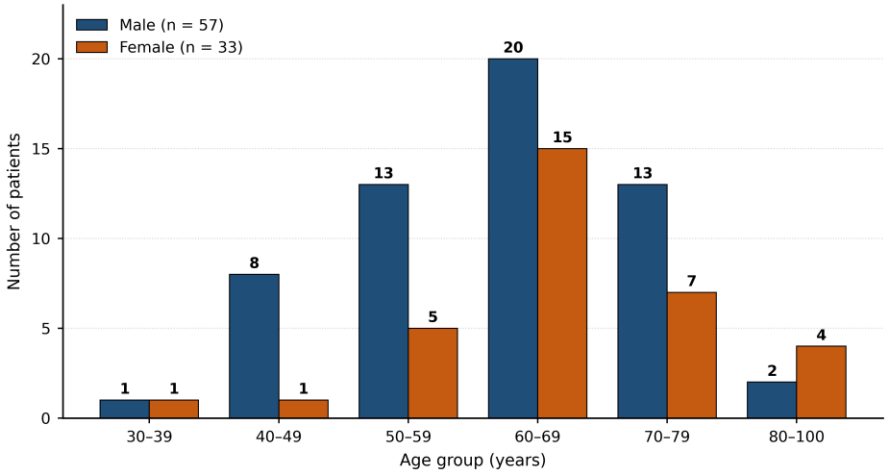


**Fig. 3: Age-wise and gender-wise distribution of the study population (N = 90).**

**Drug-related problems**

Twenty drug-related problems were identified over the study period, equivalent to one problem for every 4.5 patients admitted. Adverse drug reactions were the most frequent category, accounting for 11 problems (55.0 per cent), followed by medication errors (7; 35.0 per cent) and drug–drug interactions (2; 10.0 per cent). The reactions observed were, almost without exception, predictable pharmacological consequences of the agents involved: hypoglycemia attributable to insulin and metformin, gastritis and gastrointestinal ulceration associated with aspirin, dyspnoea following ticagrelor, hypokalemia with furosemide, hyponatremia with telmisartan and symptomatic hypotension with metoprolol.

The medication errors comprised missed doses, incorrectly timed and duplicated doses, subtherapeutic dosing and a single enoxaparin overdose. Both interactions involved the combination of aspirin with ticagrelor and declared themselves clinically as bleeding, one as haematuria and the other as haematemesis. The operational categorisation is presented in Table 3.

**Table 3: Operational categorisation of the drug-related problems identified (n = 20).**

| Category | Representative examples | n | % |
|---|---|---|---|
| Adverse drug reactions | Hypoglycemia (insulin, metformin); gastritis and gastrointestinal ulceration (aspirin); dyspnoea (ticagrelor); hypokalemia (furosemide); hyponatremia (telmisartan); hypotension (metoprolol) | 11 | 55.0 |
| Medication errors | Missed dose (atorvastatin, enoxaparin); subtherapeutic dose (metoprolol, furosemide); enoxaparin overdose; duplicated and incorrectly timed doses | 7 | 35.0 |
| Drug–drug | Aspirin with ticagrelor, manifesting as haematuria; aspirin with | 2 | 10.0 |

| | | | |
|---|---|---|---|
| interactions | ticagrelor, manifesting as haematemesis | | |
| **Total** | | **20** | **100.0** |

*Percentages are calculated against the 20 drug-related problems identified. Examples listed are representative of each category and are not an exhaustive line listing.*

When the same 20 problems were mapped onto the Pharmaceutical Care Network Europe framework, treatment-safety issues predominated, accounting for 14 problems (70.0 per cent). Treatment-effectiveness problems contributed 4 (20.0 per cent) and treatment or administration process problems the remaining 2 (10.0 per cent). The distribution across both classification schemes is shown in Table 4 and Fig. 4.

**Table 4: Drug-related problems classified by Pharmaceutical Care Network Europe version 9.1 primary domain (n = 20).**

| Primary domain | Description | n | % |
|---|---|---|---|
| Treatment safety (P2) | Adverse drug events and harmful drug–drug interactions, including anticoagulant overdose | 14 | 70.0 |
| Treatment effectiveness (P1) | Subtherapeutic dosing and omitted or missed doses | 4 | 20.0 |
| Treatment and administration process (P3) | Timing and duplication errors | 2 | 10.0 |
| **Total** | | **20** | **100.0** |

*The single enoxaparin overdose has been assigned to the treatment-safety domain rather than to the administration-process domain, because the consequence at issue was the risk of drug-induced harm rather than a failure of the administration process itself. Percentages are calculated against the 20 problems identified.*

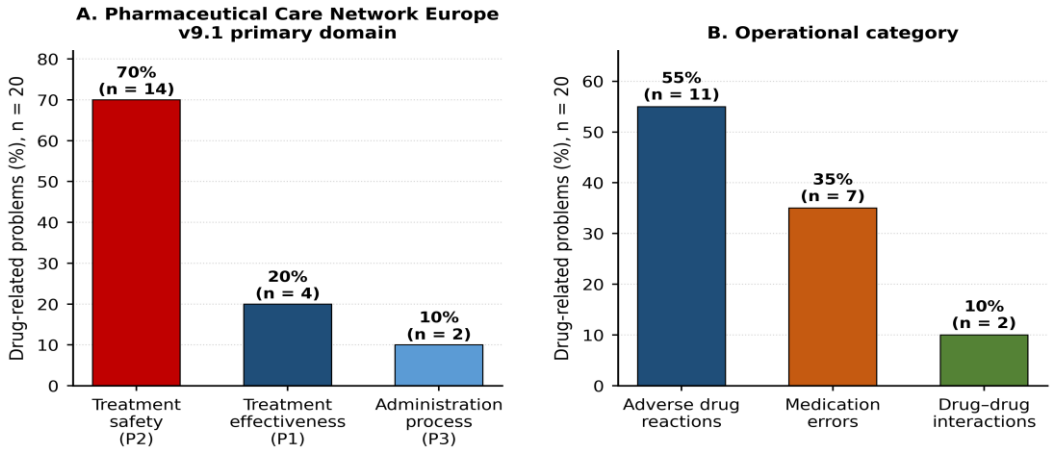


**Fig. 4: Distribution of drug-related problems by Pharmaceutical Care Network Europe version 9.1 primary domain (panel A) and by operational category (panel B); n = 20.**

## DISCUSSION

This study set out to examine prescribing and medication-related harm together, in the same ninety patients, over the same six months. The cohort was predominantly elderly and male, with a significant male excess and a clear concentration of cases in the sixth and seventh decades. That distribution is unsurprising and accords closely with earlier reports from comparable tertiary centres,[14] and with drug utilization surveys in cardiovascular inpatients elsewhere in South Asia.[6] The clinical significance lies less in the demographic finding itself than in what follows from it: an elderly cardiac population carries reduced renal reserve, altered body composition and a greater probability of concurrent illness, all of which narrow the margin for error in dosing. Rational prescribing in older patients has long been identified as a distinct competency rather than a straightforward extension of adult practice.[17]

Diabetes mellitus and hypertension dominated the comorbidity profile, mirroring the well-established epidemiological coupling between metabolic disease and coronary atherosclerosis.[9] Their prevalence here — more than four in ten and nearly four in ten respectively — is consistent with the prevalence reported in tertiary cardiovascular cohorts from other regions of the country.[13] These conditions do more than accompany ischemic heart disease; they generate prescribing in their own right, and the mean of 6.5 medicines per patient recorded in this study is a direct arithmetic consequence of treating three or four chronic diseases simultaneously in a single admission.

The prescribing pattern itself was broadly aligned with guideline-directed medical therapy. Heavy reliance on antiplatelet agents, particularly aspirin and ticagrelor, coupled with near-universal statin cover and widespread enoxaparin anticoagulation, is concordant with contemporary secondary-prevention recommendations and with the prescribing trends described from comparable centres.[12] A similar concentration of antiplatelet and lipid-lowering prescribing has been reported from tertiary hospitals in the wider region.[18] The marked preference for atorvastatin over rosuvastatin echoes earlier statin utilization findings and probably reflects a combination of familiarity, formulary availability and acquisition cost rather than any deliberate pharmacological preference.[19] Cost considerations of this kind are known to shape cardiovascular prescribing appreciably in publicly funded hospitals.[20] Encouragingly, the appearance of sacubitril–valsartan, ivabradine and the sodium–glucose cotransporter-2 inhibitor dapagliflozin indicates that recently established cardioprotective

therapies are being taken up in routine practice at this centre rather than remaining confined to the literature.

Twenty drug-related problems were identified, with adverse drug reactions forming the largest share. What is notable is not their frequency but their character. Nearly all were predictable, dose-related extensions of the known pharmacology of commonly used cardiovascular and antidiabetic drugs — hypoglycemia, electrolyte disturbance, gastrointestinal injury and bleeding — a spectrum that matches the drug-related problem profile reported in cardiac inpatients elsewhere.[10] This is consistent with the long-standing observation that the majority of hospitalised patients experience at least one drug-related problem during admission, and that most such problems are type A reactions rather than idiosyncratic events.[7] Studies confined to patients with ischemic heart disease have reported a comparable predominance of safety-domain problems.[15] Mapping the present findings onto the Pharmaceutical Care Network Europe framework made the same point quantitatively: seven of every ten problems fell within the treatment-safety domain, indicating that the principal hazard in this setting is harm arising from otherwise appropriate medicines, not failure to treat.

Medication errors were fewer but clinically more troubling, precisely because they were preventable. Missed doses of atorvastatin and enoxaparin, subtherapeutic dosing of metoprolol and furosemide, and a single enoxaparin overdose each carry tangible consequences in a cardiac population: a missed anticoagulant dose in an acute coronary syndrome is not an administrative inconvenience. Similar deficiencies in dosing and administration have been documented among cardiovascular patients in intensive care.[21] The two interactions, both arising from dual antiplatelet therapy and both declaring themselves as bleeding, illustrate the narrow safety margin of intensified antithrombotic regimens. Neither combination was inappropriate — dual antiplatelet therapy was indicated in both patients — which is exactly why interactions of this type are missed: the prescription is correct, and only the monitoring is deficient. Taken together, these observations make a concrete case for structured clinical pharmacist review, an intervention repeatedly shown to detect and resolve such problems before they translate into harm.[8]

**Limitations**

Several limitations qualify these findings. The study was conducted at a single centre over six months with a modest sample, which constrains generalisability to other institutions and other

case mixes. The observational design captured drug-related problems as they were recognised during routine daily review rather than through exhaustive prospective surveillance with trigger tools, so the true burden is likely to be underestimated rather than overstated. Causality and severity of the observed reactions were not formally graded using validated scales, and preventability was not scored; nor were the economic consequences of the problems identified quantified. Finally, because prescription entries rather than exposed patients were used as the denominator for the utilization analysis, the class percentages describe prescribing volume and should not be read as the proportion of patients receiving each drug. Larger multicentre studies incorporating validated causality, severity and preventability instruments, together with an economic component, would materially strengthen the evidence base.

These constraints notwithstanding, the study offers a coherent real-world account of how ischemic heart disease is treated in this setting and, more usefully, of where that treatment goes wrong. Prescribing is not the weak link; monitoring is. That distinction has direct operational implications, because it identifies the ward round and the daily medication review, rather than the initial prescribing decision, as the point at which pharmaceutical care should be concentrated.

## CONCLUSION

Prescribing for ischemic heart disease at this tertiary care teaching hospital conformed broadly to guideline-directed therapy, with appropriate use of antiplatelet agents, statins, anticoagulants, diuretics and antianginal drugs, and with encouraging adoption of newer cardioprotective agents. Against that satisfactory prescribing profile, a measurable burden of drug-related problems was nonetheless identified, dominated by preventable treatment-safety events arising from medicines that were themselves correctly indicated. The mean of 6.5 medicines per patient defines the risk environment in which these events occurred. Routine clinical pharmacist review and active pharmacovigilance, embedded within the cardiology inpatient team rather than offered from outside it, represent a direct and practicable means of reducing this burden and improving both medication safety and therapeutic outcomes in this population.

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**CONFLICT OF INTEREST**

The authors declare that they have no actual or potential conflict of interest, financial or otherwise, in relation to the work reported in this manuscript.

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